

# Chapter 08: The Memory System

## Lesson 15:

# Semiconductor Read-Only Memories—ROMS

# Objective

- Understand the read only memory, ROM, PROM, EPROM, EEPROM and Flash

# ROM

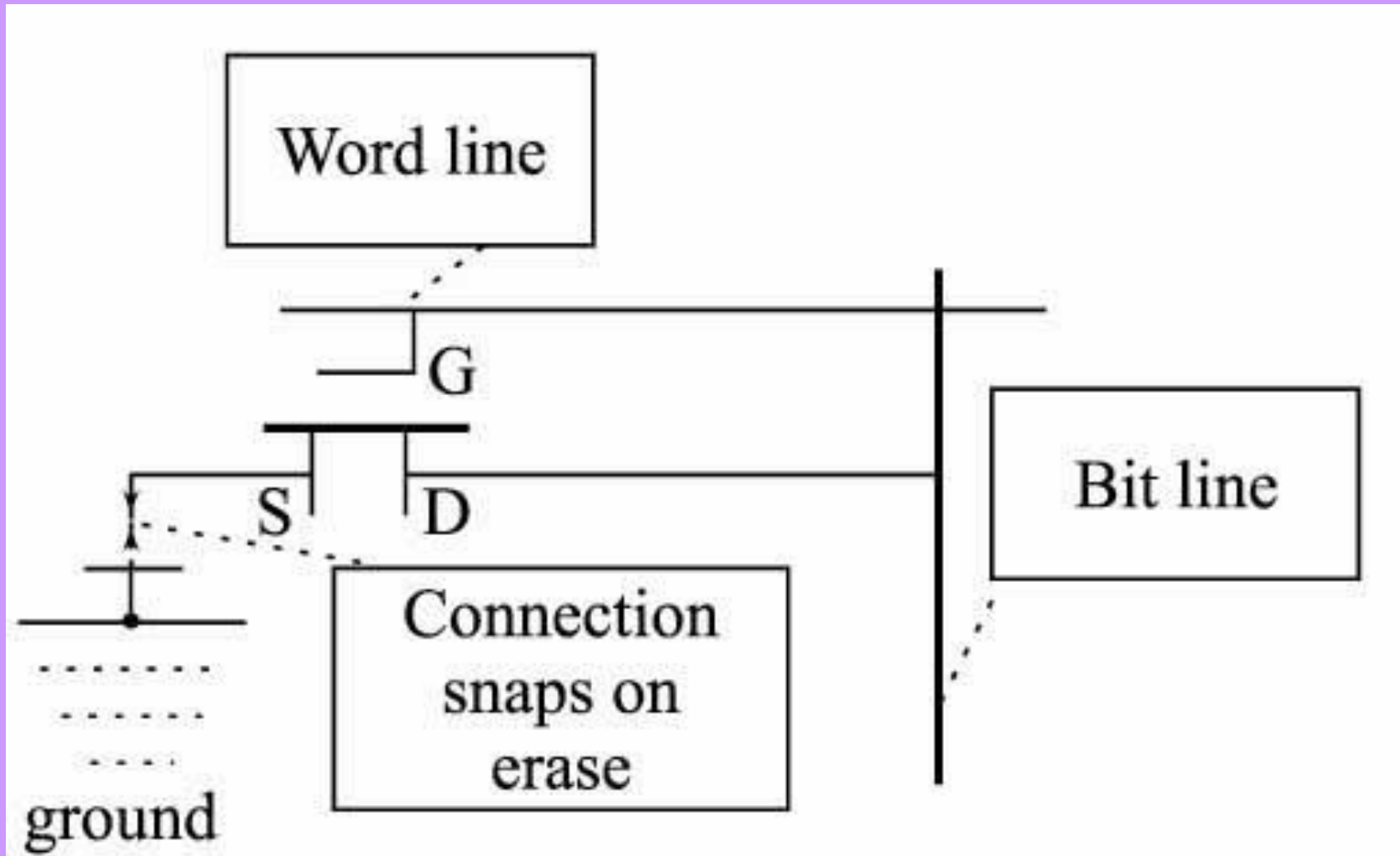
# ROM

- The read only memory that gives an output 1 only if a bit is not programmed, or is erased by an erase mechanism on writing 1
- Non-volatile
- Random accessed— each address location has equal access time
- ROM memory can be prepared by masking at a foundry

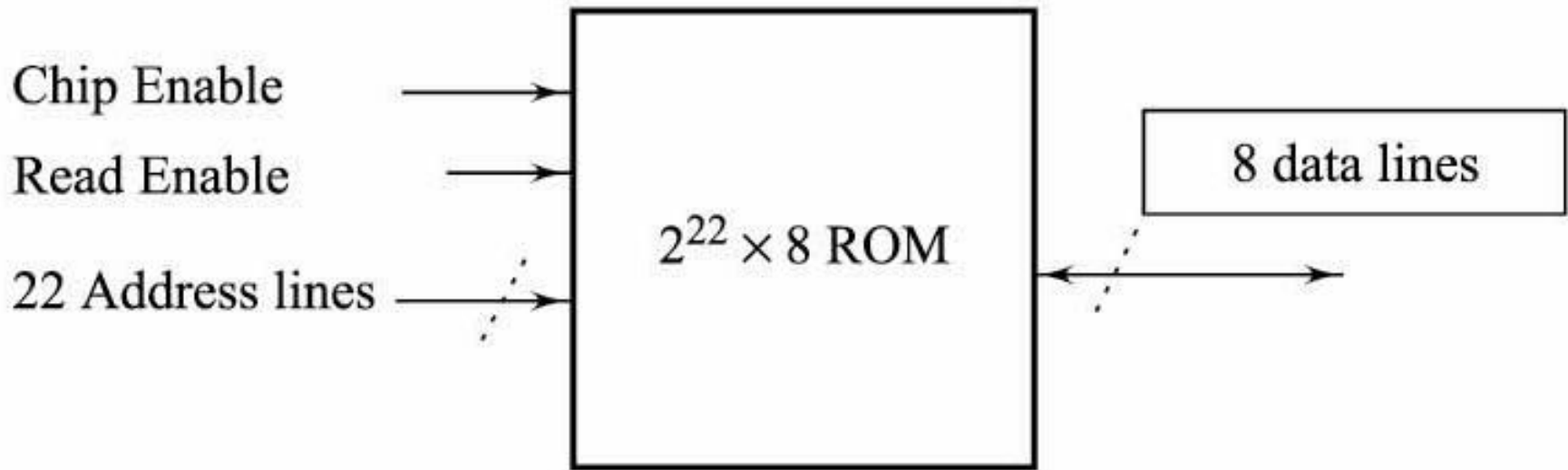
# ROM

- A circuit designer provides a mask and the connection to the ground from the transistor gets joined or snapped at each bit cell at the foundary as per the mask

# ROM one-bit cell for showing 1 on word line if connection not joined or snapped else 0



# 4 MB ROM chip in a computer system



# PROM



# PROM

- A provision that the user can program them
- During the development of an application or product program, repeated programming and testing are needed
- EPROM and EEPROM— two forms of PROMs

# EPROM

# EPR0M

- An advantage that it can be erased by ultraviolet (UV) light
- The manufacturer of the EPR0M provides a quartz window through which the UV light can be passed to erase the EPR0M
- In the erased state, all bytes at all addresses are 0xff
- The UV light generates a charge that creates a high internal voltage to snap the links at each cell

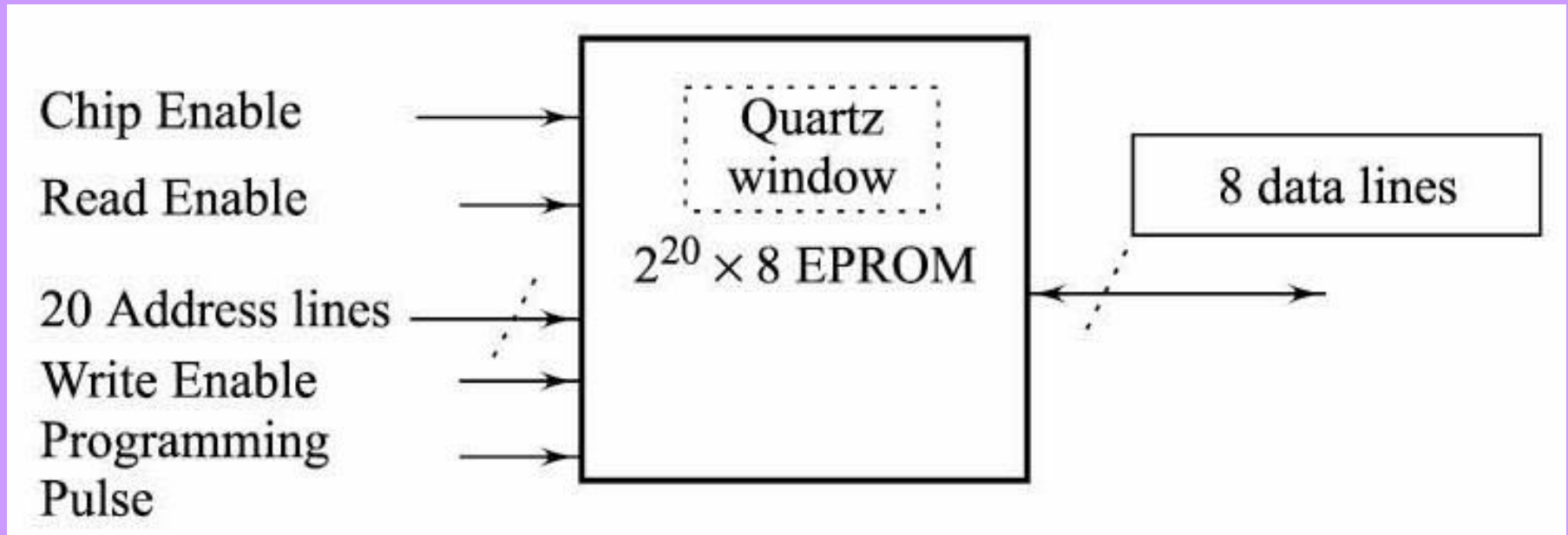
# EPRM device programmer process for programming at an address

- Using a device programmer all the links for a byte can be fused and joined together
- A higher than usual voltage applied
- Address bits and data bits for the desired byte sent
- A pulse is sent for a required duration

# EPRROM programming at the addresses

- The device programmer repeats these steps at each address and programs the EPRROM byte by byte
- Programming an EPRROM bit means converting a cell bit from 1 to 0
- The EPRROM can be repeatedly erased, and bytes repeatedly written on the erased EPRROM

# One MB EPROM and memory device programmer inputs



# EEPROM

# EEPROM

- In many applications, nonvolatile data have to be generated in a program application and need to be stored
- Example— in a mobile phone the telephone numbers and caller IDs are to be stored permanently till such time the user wants to erase that information
- Similarly, the user may like to erase previously entered information



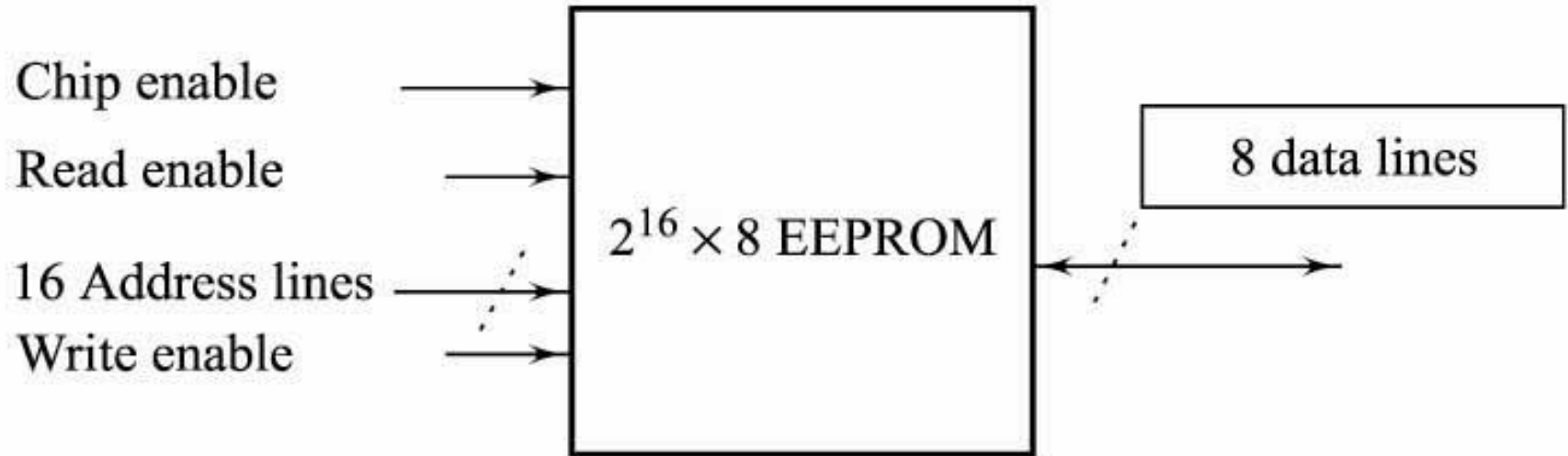
# EEPROM

- EEPROMs advantage—the bytes in them can be selectively erased by writing 1s, and each byte can be stored again by writing the desired byte having 1s and 0s
- An EEPROM needs two write operations at an address
- One for erase and one for writing

# EEPROM

- RAM writes the byte directly without first erasing that address
- But in the EEPROM, the written byte is nonvolatile while in RAM it is volatile

# 64 kB EEPROM in a computer system



# Flash

# Flash

- In many applications, bulk nonvolatile data have to be generated in a program application and need to be stored
- For example, in a digital camera, an image can be of 100 kB or more

# Flash

- Another example: consider the memory stick in a mobile PC
- It downloads music from the net and stores it on the stick

# Flash

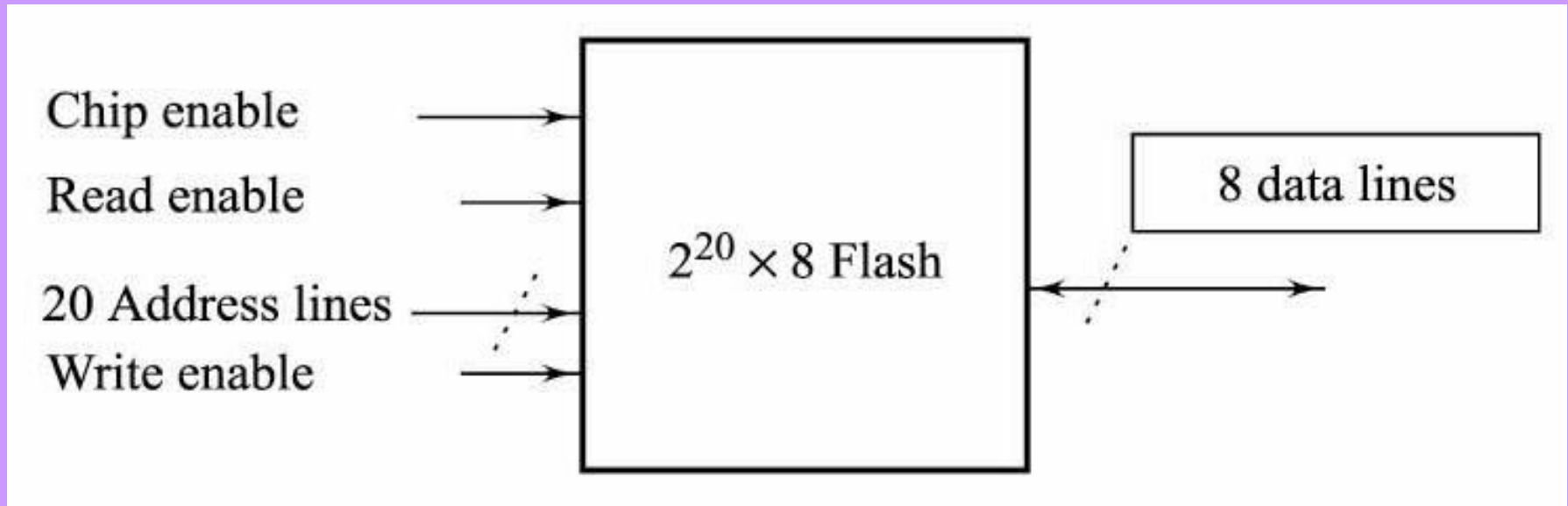
- Erasing each byte or an array of bytes, like in an EEPROM, is very inconvenient
- In a flash, a single transistor controls a sector or all the sectors of memory and can do a bulk erase of the memory

# Flash

- In mobile devices and cameras
- A single operation of writing 1s can erase a sector or all sector bytes in them and each byte can be then stored again by writing the desired byte having 1s and 0s
- Flash needs one write operation for all bytes erase and one write operation for each byte for programming it



# One MB flash in a computer system like camera or mobile device



# Memory Stack

# Memory stick

- A new flash memory device in form of a card
- The card is inserted into a mobile phone or PocketPC or digital camera or music system
- Lateley memory stick of 8 GB have become common

# SD card

# Secure Digital Association (SD)

- Created a new flash memory card format, called SD format
- SDIO card used in handheld mobile devices, PDAs, digital cameras and embedded systems
- SD card size is just  $0.14 \text{ cm} \times 2.4 \text{ cm} \times 3.2 \text{ cm}$
- SD card also allowed to stick out of the handheld device open slot, which can be at the top in order to facilitate insertion of the SD card

# SDIO IO functionalities

- SDIO (Secure Digital Input Output) card can have upto eight logical functions
- SDIO can provide additional memory storage in SD format
- SDIO functions include IOs with several protocols, for example, IrDA adapter, Ethernet adapter, GPS or WiFi, Bluetooth, WLAN, digital camera, barcode or RFID code readers

# Summary

# We learnt

- Read only memory and the signals to ROM chips
- 22, 23 and 24 address, 8-data, RD and chip-enable lines in 4 MB, 8 MB and 16 MB chips
- Flash memory, memory stick
- SD card



End of Lesson 15 on  
**Semiconductor Read-Only Memories—ROMS**